An Account of a Method of dividing Astronomical and other Instruments, by ocular Inspection; in which the usual Tools for graduating are not employed; the whole Operation being so contrived, that no Error can occur but what is chargeable to Vision, when assisted by the best optical Means of viewing and measuring minute Quantities. By Mr. Edward Troughton. *Communicated by the Astronomer Royal.* Read February 2, 1809. [*Phil. Trans.* 1809, *p.* 105.]

The description of the method is preceded by some account of the steps by which the author acquired his present skill in the division of instruments, and by observations on the comparative merits of the respective methods employed by Bird, by the late Mr. John Troughton, and by other artists; after which Mr. Troughton proceeds to the account of his own, which, he says, was first suggested by the action of the perambulator. In the first place, the circle to be divided is to be turned on its inner and outer edges, to correct circles, in the most exact and careful manner. A roller is then adapted to its edge, having its diameter, as nearly as possible, one sixteenth that of the circle; and since perfect equality could not be directly obtained, the exterior surface of the roller is rendered slightly conical, by a difference of $\frac{1}{1000}$th of an inch in the diameters of its upper and under surface; so that by a small motion in the direction of its axis, some one part of its surface may be found perfectly adapted to its purpose. The roller itself being next divided into sixteen parts, each of these will correspond with $\frac{1}{256}$th of the whole circle; a number chosen on account of its being capable of continual bisection, although these divisions will coincide with a very small number of the ultimate divisions of the circle.

By means of two microscopes, one over the circle, and the other over the roller, the correct adaptation of the circle and roller to each other is first ascertained, or duly adjusted by raising or depressing the roller. An instrument for making dots, with uniformity, is next to be fixed at a due distance from the edge of the circle; and when one division of the roller is brought exactly under the wire of its microscope, the pointer being pressed down, makes the first dot at any point which may have been previously fixed upon. When the second division of the roller comes under its wire, a second dot is made in a similar manner, and so on till the whole 256 are completed, at intervals that are nearly equal. But it is not really of any consequence how erroneous they may be found by the very important process of examination which is next to follow, and which constitutes the intrinsic excellence of this method.

The dividing apparatus having next been removed, the circle is to be placed in the same position it is intended to have when employed for observation; and two microscopes are to be placed, at opposite sides, for the examination of the point of 180°. The dot at zero, and that at 180°, being first bisected, the circle is turned half round; and if when the zero point is bisected, that at 180° is found not to be bisected, the apparent error of its position is measured by the micro-

meter, and the half of that quantity is noted in a table + or —, according as its position is found forward or backward in the intended order of the future divisions. The four quadrants are next examined in the same manner, by removing the micrometer microscope to a position 90° distant. Half the observed error is again the real *difference* of the two portions of semicircle compared; and since the sum of the quadrants (though not accurately 180°) is known by the previous examination, the quantities themselves are known, and the real error of each quadrant is then noted. In a similar manner the succeeding bisectional points, at the distances from each other of 45°, 22° 30′, 11° 15′, 5° 37′ 30″, 2° 48′ 45″, and 1° 24′ 22½″, are successively examined; and the real errors of the several dots, from their true places, are computed and arranged in a table, so that by means of the dots themselves, together with their tabulated errors, the true places for the future divisions may be correctly known.

For the purpose of laying off these ultimate divisions, the circle is again placed in a horizontal position, and the roller is again applied to it. But as it would not be easy to divide the roller itself with sufficient exactness, a sector is added to the apparatus, having its radius four times that of the roller. This sector being fitted tight on the axis of the roller, moves with an angular velocity, which is sixteen times that of the circle; so that one of the former divisions of the circle is measured by an arc upon the sector of 22° 30′. But since the ultimate divisions are intended to be 5′ each, this sectorial arc must be divided into spaces of 80′ each; and of these spaces 16⅞ will be equal to 22° 30′, and will correspond with the true 256th part of the circle, or average space between the dots before laid down. The sector has consequently marked upon it eighteen intervals of 80′ each, the first and last of which are subdivided into eight parts of 10′ each. The fractional parts at each extremity are for the purpose of making the requisite coincidences with the former bisectional dots, and the intermediate sixteen divisions are the scale by which the true divisions are laid down.

Since this sector, though very correctly divided, may be liable to central error, its arc is made capable of a small adjustment, whereby 16⅞ths of its divisions are, by trial, made to correspond accurately with $\frac{1}{256}$th part of the circle.

For cutting the divisions, the same apparatus is employed as was used by Ramsden in his dividing engine, but originally invented by Hindley, of York. These, together with the two micrometer microscopes, constitute the whole apparatus to be employed.

The dividing point is first placed over that part of the circle at which the divisions are intended to be begun, while one of the microscopes is fixed accurately over the first of the 256 dots; and at the same time the first division of the sector is made to correspond with the wire of the second microscope.

The first division being now made, the circle is carried forward by a slow motion till the second division of the sector comes under the wire of its microscope, and the second division is now made upon

the circle. The succeeding divisions, to the sixteenth, are all made in the same manner. In the next place, the error of the second bisectional dot is to be set off by the micrometer head of the first microscope; and the contemporaneous coincidence of this dot, with that of the seventh of the succeeding small divisions of the sector, is to be observed, and then the sector must be moved backwards upon its axle sixteen divisions; so that it will have to move forward again by the motion of the circle one eighth of a division before the seventeenth division upon the circle is to be cut. The succeeding divisions follow in due course to the thirty-second, when allowance must be again made for the known error of the third dot, and the work proceeds in the same manner to the completion of the circle.

In the application of this method to the instrument now constructing for the Royal Observatory, which is to be divided on its edge, instead of having the divisions upon the face of the instrument, nothing new in principle is requisite, but merely a new position given to the roller, and other apparatus employed; but as that instrument may deserve a particular description, the author hopes to have an opportunity of giving an account of its construction, to the Society, at no very distant period.

A Letter on a Canal in the Medulla Spinalis of some Quadrupeds. In a Letter from Mr. William Sewell, *to* Everard Home, *Esq. F.R.S.* Read December 8, 1808. [*Phil. Trans.* 1809, *p.* 146.]

The canal, which is the subject of this letter, appears to have been discovered by the author in the year 1803, although no account has been given of it till the present description was drawn up at the request of Mr. Home.

From the extremity of the sixth ventricle of the brain in the horse, bullock, sheep, hog, and dog (which corresponds to the fourth ventricle in the human subject), a canal passes in a direct course to the centre of the spinal marrow, and may be discovered in its course by a transverse section of the spinal marrow in any part of its length, having a diameter sufficient to admit a large-sized pin; and it is proved to be a continued tube, from one extremity to the other, by the passage of quicksilver in a small stream in either direction through it.

This canal is lined by a membrane resembling the tunica arachnoidea; and it is most easily distinguished where the large nerves are given off in the bend of the neck, and at the sacrum.

A numerical Table of elective Attractions; with Remarks on the Sequences of double Decompositions. By Thomas Young, *M.D. For. Sec. R.S.* Read February 9, 1809. [*Phil. Trans.* 1809, *p.* 148.]

The attempts that have been made by some chemists to represent the attractive forces of chemical bodies by number, having been limited and hastily abandoned, some important consequences which